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Patentanmeldung Nr. **Patent application No.** **Demande de brevet n°**

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Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
p.o.

R C van Dijk

PRIORITY DOCUMENT

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(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

Metallurgical vessel

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METALLURGICAL VESSEL

The present invention relates to a metallurgical vessel comprising a bottom portion, a sidewall and a lance arrangement of at least two lances for supplying oxygen containing gas to the interior of the vessel in operation wherein each lance comprises an end portion for emitting oxygen containing gas. The present invention also relates to a method of iron making.

The term metallurgical vessel refers to a vessel suitable for treating metal or metal oxide, metal smelting, refining or reducing.

The object of the present invention is to provide a metallurgical vessel which can be used on a large scale with increased production efficiency and reduced clogging of equipment positioned in a roof portion of the vessel.

The present invention improves on the prior art as the lance arrangement is suitable for increasing in operation a downwardly directed flow of post-combusted gases at the side wall of the vessel and an upwardly directed flow of post-combusted gases in the centre of the vessel.

The term post-combusted gases refers to the gases which are produced during reactions in the metallurgical vessel and are subsequently at least partially post combusted.

The present invention has the considerable advantage that it can be successfully used for vessels of large diameter by stimulating a very favourable gas flow in the body of the vessel. The gas flow results in reduced heat loads on the walls whilst the plurality of lances ensure a good distribution of oxygen containing gas and therefore good heat distribution over the vessel area, thereby increasing production efficiency. The present invention also mitigates the problem of clogging of and damage to, e.g. ports, seals, sensors and measuring equipment positioned in the roof portion of the vessel which are expensive and difficult to replace or repair. This problem of clogging arises when particulates are entrained in the upward flow of post combusted gases directed to the roof portion of the vessel. The lance configuration of the present invention creates a downward flow of post combusted gases at the sidewall whilst the upwardly directed flow occurs at the centre of the vessel. Any particulates entrained in the upward flow therefore pass up the centre of the vessel and have less chance of coming into contact with any of the equipment, ports, seals or sensors projecting through the roof.

EP 0 735 146 discloses a metallurgical vessel of the converter type in which pre-reduced iron ore undergoes a final reduction. The bottom portion of the metallurgical vessel contains the iron bath whilst the wall or side wall extends upwardly from the bottom portion, enclosing the slag layer. The roof portion extends from the top of the sidewall over the interior of the vessel and connects with the melting cyclone. A plurality of lances project through the wall of the metallurgical vessel and supply oxygen to the interior of the vessel. The lances are specified as being orientated vertically as much as possible in order to achieve the same effect as when using a central lance i.e. that the oxygen can be supplied to the vessel at the same place above the slag layer even when the level of slag layer varies.

As mentioned above the present invention improves on the prior art as the lances are configured to increase a downwardly directed flow of post-combusted gases at the side wall of the vessel and an upwardly directed flow of post-combusted gases in the centre of the vessel.

In the metallurgical vessel of the present invention at least one of the lances may be provided with means for emitting a plurality of jets of oxygen containing gas from its end portion. Such a lance can emit oxygen over a wider surface area of the contents of the vessel compared to a single jet.

The lances are preferably configured with at least one of the lances projecting through the roof portion of the metallurgical vessel. The roof portion of the vessel extends from the top of the sidewall to the melting cyclone. At least one of the lances thus penetrates through part of the vessel that does not come into contact with the contents of the vessel thereby avoiding damage to the seal around the lance at the point it penetrates the vessel.

At least one lance is preferably arranged to direct the oxygen containing gas inwards towards the central axis of the metallurgical vessel. Directing the gas inwards towards the central axis of the vessel creates an area of low pressure at the lance end portion resulting in post combusted gas being entrained downward at the sidewall towards the end portion of the lance whilst an upward flow of post combusted gas is generated up through the centre of the vessel. When the metallurgical vessel is upright the central axis extends essentially vertically through the centre of the vessel.

At least one of the lances may be inclined from the vertical with its end portion inclined towards the central axis of the metallurgical vessel. Inclining a lance directs the oxygen containing gas inwards towards the central axis of the metallurgical vessel and improves the distribution of oxygen containing gas over the surface of the contents of the vessel.

The end portion of at least one lance may also be configured to direct the oxygen containing gas towards the central axis of the metallurgical vessel at a greater angle from the vertical than the angle of inclination of the lance thereby increasing the upward and downward gas flow generated in the vessel.

The lances may be adjustable in height and therefore able to be positioned at an optimal height over the surface of the of the vessel contents when the vessel is at varying levels of fullness. The angle of inclination of the lances may also be adjustable to enable the distribution of oxygen containing gas over the surface of the contents of the vessel to be optimised.

The lance end portions may all be positioned at an equal distance from the sidewall to achieve the most effective heat distribution over the surface of the vessel contents to maximise production efficiency. Preferably three or more lances supply oxygen containing gas to the contents of the vessel to ensure optimum heat distribution and production efficiency.

Particulate material may preferably be added to the metallurgical vessel via feed chutes positioned at a short distance from the lances. The downward gas flow in the vicinity of the sidewall thus entrains the particulate material in the form of e.g. coal fines and transports it down towards the end portions of the oxygen lances and the slag layer. This avoids the problem of a significant proportion of any particulate material added to the vessel being lost, due to

particles being entrained in the upward gas flow, before reacting with the contents of the vessel. The preferred embodiment thus results in a significantly lower loss of particulate material, such as coal fines, from the vessel and a higher production efficiency as a greater proportion of the particulate material is available as a reactant.

The loss of particulate material is further minimised if each lance has a corresponding feed chute so that the particulate material added through the chute is entrained into the circulating gas flow generated by the lance. The optimal position for each chute is to be positioned between the lance and the sidewall of the metallurgical vessel, in a radial direction, where the downward flow of the post combusted gases is at a maximum.

The metallurgical vessel of the present invention preferably comprises a melting cyclone positioned above, and in open communication with, the vessel. None of the oxygen lances thus has to withstand the heat and corrosive environment of the cyclone as they do not extend through the cyclone. Such a melting cyclone is disclosed in Dutch patent NL C 257692 and EP 0735146.

The lances are preferably positioned to avoid contact with molten material passing downwards from the melting cyclone to the metallurgical vessel so that the molten material does not damage the lances. Replacement and/or repair of damaged lances is costly and reduces production efficiency.

The metallurgical vessel of the present invention may be used for iron making and steel making.

The present invention also relates to a method of reducing iron oxide into iron using a metallurgical vessel in accordance with the invention and comprising the steps of supplying iron oxides to the vessel and reducing the iron oxides by supplying carbonaceous material to the vessel and supplying oxygen containing gas to the iron oxides via the plurality of lances.

The present invention also relates to a method of iron making comprising the steps of:

- conveying iron-oxide containing material into a melting cyclone,
- pre-reducing said iron-oxide containing material by means of reducing post combusted gases originating from the metallurgical vessel,
- at least partly melting the iron-oxide containing material in the melting cyclone by supplying oxygen containing gas to the melting cyclone and effecting a further post combustion in said reducing post combusted gases,
- permitting the pre-reduced and at least partly melted iron-oxide containing material to pass downwardly from said melting cyclone into the metallurgical vessel in which final reduction takes place and
- effecting the final reduction in the metallurgical vessel in a slag layer by supplying oxygen containing gas to the metallurgical vessel, via at least two lances configured to improve a downwardly directed flow of post-combusted gases at the side wall of the vessel and an upwardly directed flow of post-combusted gases in the centre of the vessel, and supplying coal to the metallurgical vessel and thereby forming a reducing gas and

effecting at least partial post combustion in said reducing gas in said metallurgical vessel by means of said oxygen containing gas supplied thereto.

BRIEF INTRODUCTION TO THE DRAWINGS

Embodiments of the invention will now be described by way of non-limitative example, with reference to the accompanying drawings, in which:

Figure 1 shows an apparatus in accordance with the invention.

Figure 2 shows a view along axis "A" of figure 1.

Figure 3 shows a simulation of a section of the apparatus with one lance projecting into the vessel section and shows the simulated trajectory of coal particles added at a short distance from the lance.

Figure 4 shows simulation of a section of the apparatus with one lance projecting into the vessel section and shows the simulated trajectory of coal particles added between the lances.

Figure 5 shows a lance end portion having four ports for emitting four jets of oxygen containing gas.

DESCRIPTION OF A PREFERRED EMBODIMENT

The apparatus in figure 1 comprises a metallurgical vessel 1, a melting cyclone 2 (details not shown) and a plurality of lances 3, of which two are shown. More lances may be used depending on, for example, the size of the vessel and the performance parameters of the lances. The metallurgical vessel itself comprises a bottom portion 4, a sidewall 5 and a roof portion 6 which extends from the top of the sidewall 5 to the melting cyclone 2. The metallurgical vessel contains an iron bath 11 with a slag layer 10 on top and the vessel comprises at least one tap hole 19 for tapping off molten iron and slag. Oxygen containing gas is supplied to the interior of the vessel by the lances 3 which acts to finally reduce the pre-reduced iron oxide in the slag layer. During the final reduction a process gas comprising reducing carbon monoxide is produced and at least partially combusted above the slag layer 10, thereby releasing heat needed for the final reduction. The at least partially post combusted gas resulting from the post combustion is referred to as post combusted gas. Particulate coal is supplied to the interior of the vessel 1 via the feed chutes 12. The lances 3 project into the vessel through the roof 6 and are configured to create a downwardly directed flow of the post-combusted gas at the sidewall 5 of the vessel and an upwardly directed flow of post combusted gas in the centre of the vessel 9. The upwardly directed post combusted gas, comprising reducing carbon monoxide, is further post-combusted in the melting cyclone 2 with oxygen containing gas supplied to the melting cyclone. Iron oxide supplied to the melting cyclone via apparatus 13 is pre-reduced approximately to FeO and at least partly melted. The pre-reduced iron oxide 14 then falls or flows down into the metallurgical vessel 1. When the metallurgical vessel is upright the central axis extends essentially vertically through the centre of the vessel.

During operation the lances extend to above the slag layer 10 and the lances are adjustable in height so they can be positioned optimally for supplying oxygen containing gas even when the vessel is at varying levels of fullness. The lances 3 are inclined from the vertical and the end portions 8 are configured to direct a jet 7 or jets of oxygen containing gas towards the centre of the vessel either at the same inclination of the lance or at greater angle from the vertical than the inclination of the lance. Figure 5 shows in detail the end portion 8 of a lance 3 having four ports 17 which emit four jets 18 of oxygen containing gas. The lances 3 are positioned so that their ends are all of equal distance from the sidewall. The number of lances projecting into the vessel can be varied depending on the size of the metallurgical vessel and the surface area of slag covered by each lance. The number of ports in the end portion of the lances can also be varied.

Figure 2 shows the positions of the three feed chutes 12 with respect to the three oxygen lances 3 of figure 1.

Figure 3 shows a section of the vessel 1, a lance 3 projecting into the section of the vessel and the trajectories 15 of coal particles added to the vessel. The advantage obtained by adding coal particles a short distance from the lances is clear as the particles are entrained towards the slag layer with the downward flow of post-combusted gases at the sidewall of the vessel. In contrast, figure 4 shows the trajectories 16 of coal particles added between the lances. It can be seen that the majority of the particles are entrained in the upwardly directed flow of post-combusted gases in the centre of the vessel and leave the vessel. A significant proportion of the coal particles added thus never become available as reactants in the slag layer.

While the invention has been illustrated by a particular embodiment, variations and modifications are possible within the scope of the inventive concept.

CLAIMS

1. Metallurgical vessel comprising a bottom portion, a sidewall and a lance arrangement of at least two lances for supplying oxygen containing gas to the interior of the vessel in operation wherein each lance comprises an end portion for emitting oxygen containing gas characterised in that the lance arrangement is suitable for increasing in operation a downwardly directed flow of post-combusted gases at the side wall of the vessel and an upwardly directed flow of post-combusted gases in the centre of the vessel.

2. Metallurgical vessel according to claim 1 wherein at least one of the lances is provided with means for emitting a plurality of jets of oxygen containing gas from its end portion.

3. Metallurgical vessel according to claim 1 or 2 wherein at least one of the lances projects through a roof portion of the metallurgical vessel.

4. Metallurgical vessel according to any of the previous claims wherein at least one lance is arranged to direct the oxygen containing gas towards a central axis of the metallurgical vessel.

5. Metallurgical vessel according to claim 4 wherein at least one of the lances is inclined from the vertical with its end portion inclined towards the central axis of the metallurgical vessel.

6. Metallurgical vessel according to claim 5 wherein the end portion of the lance is configured to direct the oxygen containing gas towards the central axis of the metallurgical vessel at a greater angle from the vertical than the angle of inclination of the lance.

7. Metallurgical vessel according to any of the previous claims wherein the lances are adjustable in height.

8. Metallurgical vessel according to any of the previous claims wherein the end portions of the lances are all of equal distance from the sidewall.

9. Metallurgical vessel according to any of the previous claims wherein the metallurgical vessel comprises three or more lances.

10. Metallurgical vessel according to any of the previous claims wherein at least one feed chute, for adding material to the vessel, is positioned at a short distance from a lance

11. Metallurgical vessel according to claim 10 wherein a plurality of feed chutes project through a roof portion of the metallurgical vessel.

12. Metallurgical vessel according to claim 10 wherein each lance has a corresponding feed chute.

13. Metallurgical vessel according to claim 12 wherein each feed chute is positioned between the lance and the sidewall of the metallurgical vessel in a radial direction.

14. Metallurgical vessel according to any one of claims 1 to 13 comprising a melting cyclone positioned above and in open connection with the metallurgical vessel.

15. Metallurgical vessel according to claim 14 wherein the lances are positioned to avoid contact with molten material passing downwards from the melting cyclone to the metallurgical vessel.

16. Method of reducing iron oxides into iron using apparatus in accordance with any one of claims 1-15 comprising the steps of supplying iron oxides to the vessel and reducing the iron oxides by supplying carbonaceous material to the vessel and supplying oxygen containing gas to the iron oxides via at least two lances.

17. Method of iron making comprising the steps of:
   - conveying iron-oxide containing material into a melting cyclone,
   - pre-reducing said iron-oxide containing material by means of reducing post combusted gases originating from the metallurgical vessel,
   - at least partly melting the iron-oxide containing material in the melting cyclone by supplying oxygen containing gas to the melting cyclone and effecting a further post combustion in said reducing post combusted gases,
   - permitting the pre-reduced and at least partly melted iron-oxide containing material to pass downwardly from said melting cyclone into the metallurgical vessel in which final reduction takes place and
   - effecting the final reduction in the metallurgical vessel in a slag layer by supplying oxygen containing gas to the metallurgical vessel, via at least two lances configured to improve a downwardly directed flow of post-combusted gases at the side wall of the vessel and an upwardly directed flow of post-combusted gases in the centre of the vessel, and supplying coal to the metallurgical vessel and thereby forming a reducing gas and effecting at least partial post combustion in said reducing gas in said metallurgical vessel by means of said oxygen containing gas supplied thereto.

ABSTRACT

Metallurgical vessel comprising a bottom portion, a sidewall and a lance arrangement of at least two lances for supplying oxygen containing gas to the interior of the vessel in operation wherein each lance comprises an end portion for emitting oxygen containing gas characterised in that the lance arrangement is suitable for increasing in operation a downwardly directed flow of post-combusted gases at the side wall of the vessel and an upwardly directed flow of post-combusted gases in the centre of the vessel.

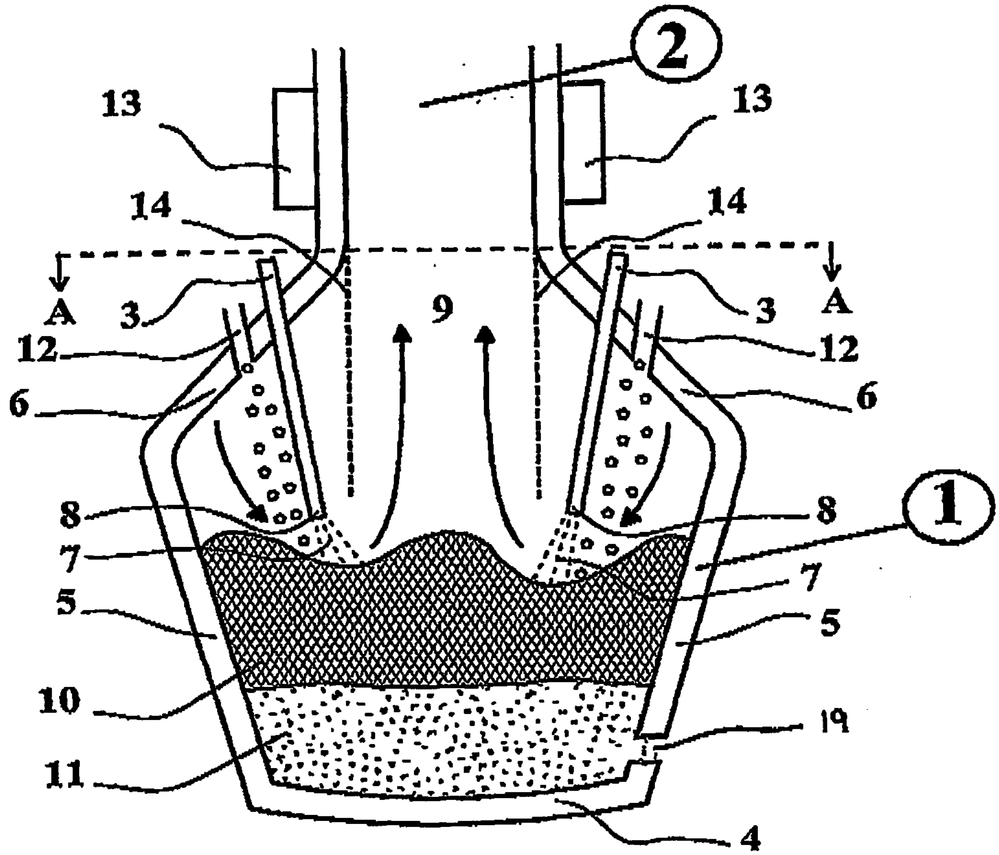


Fig. 1

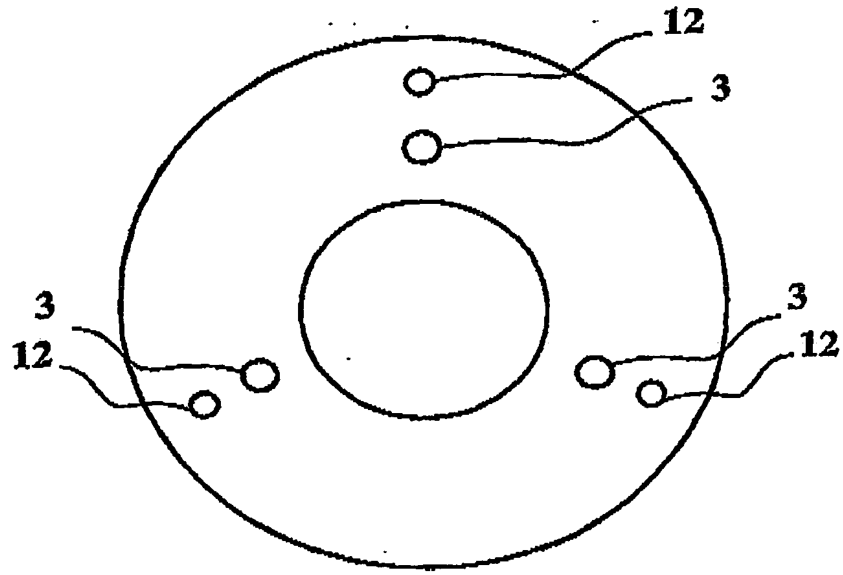


Fig. 2

Figure 3

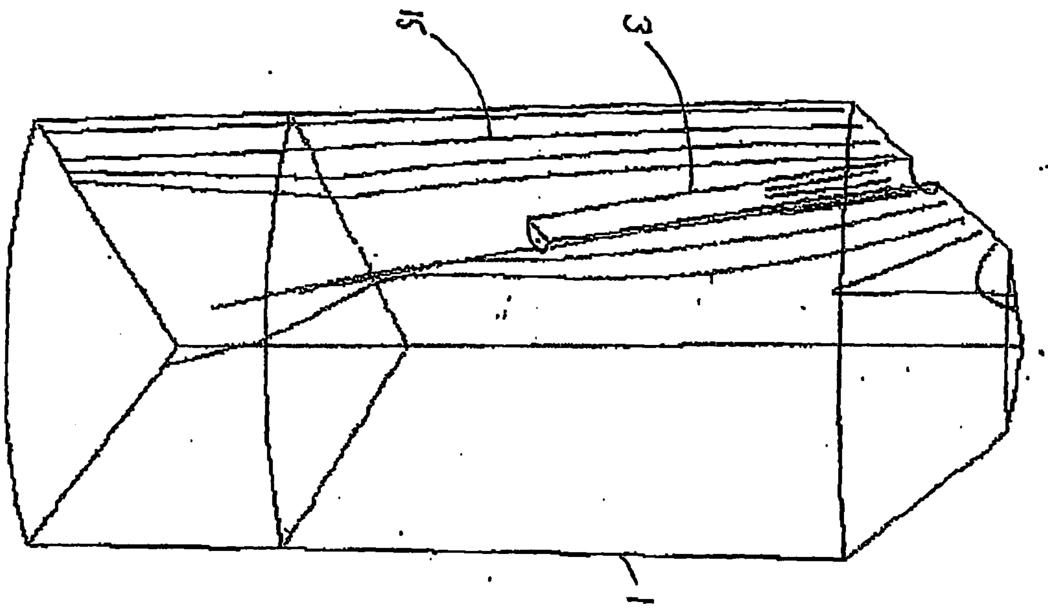
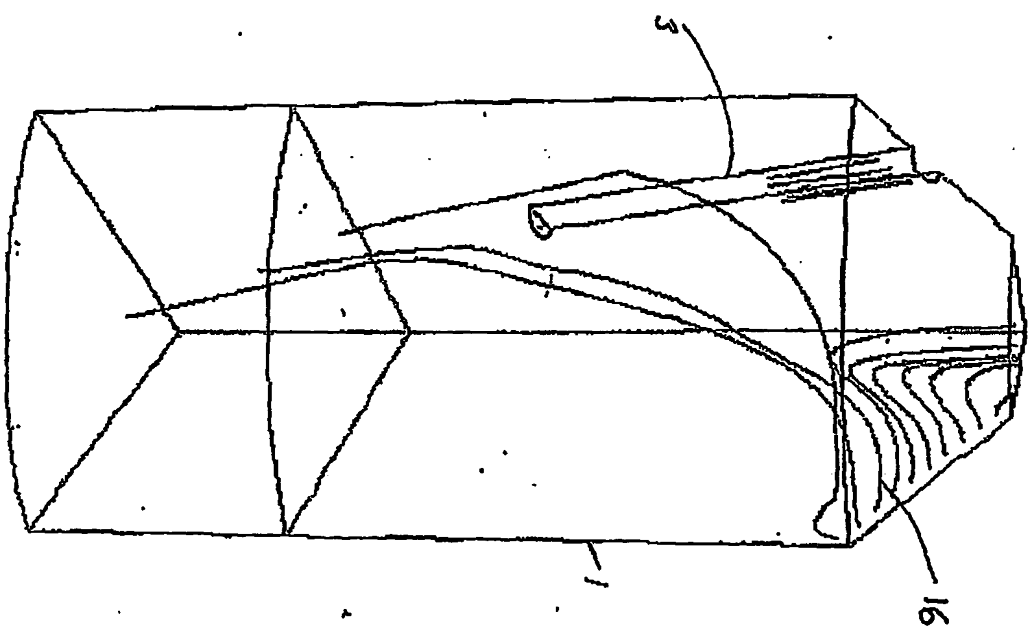


Figure 4



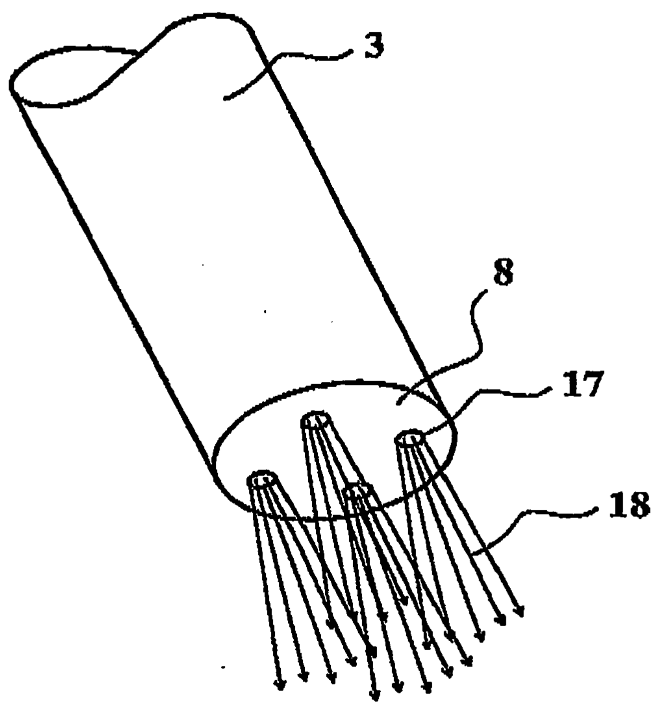


Fig. 5